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COVID-19 Disease and Chronic Health Outcomes Associated with Nicotine Use in a Great Plains Tribal Community: A Community-Based Study

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Abstract

Background: The Cheyenne River Sioux Tribe (CRST) is affected by high nicotine use and disease burden. Understanding nicotine exposure is important to recognize what groups may be at higher risk for negative health outcomes, including COVID-19.

Objective: To compare self-reported health outcomes and nicotine use between exclusive electronic cigarette (e-cig) users, users of combustible cigarettes, dual e-cig/cigarette users, and nonusers among adult residents on the CRST.

Methods: The CRST “COVID-19 – Wayakta He study” (“Are you on guard against COVID-19?”) recruited 562 participants on the reservation who filled out a 97-item survey. Regression models were used to analyze nicotine exposure, demographic characteristics, and health outcomes.

Results: Prevalence of nicotine use among participants was 53%. Reported median puffs per day was 15 for e-cig, 100 for cigarette, and 20 for dual users ($p < 0.001$). The odds of having COVID-19 were lower for nicotine users compared to nonusers ($p < 0.001$). The odds of hypertension ($p = 0.04$) and high cholesterol ($p = 0.03$) were lower for nicotine users compared to nonusers. The proportional odds were higher for nicotine users for longer COVID-19 recovery time ($p = 0.046$) and lower for more severe COVID-19 infection ($p = 0.001$).

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Author Contribution All authors contributed to the study conception and design. Funding acquisition was performed by Esther Erdei, Ana M Rule, and Rae O'Leary. Project administration was performed by Rae O'Leary. Material preparation and data collection were performed by Rae O'Leary, Jaylynn Farlee, and Brittany Youpee. Data analysis was performed by Anna Tillery. The first draft of the manuscript was written by Anna Tillery and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Ethical Approval The study protocol was approved by the Great Plains Institutional Review Board (IRB), and the IRBs at the University of New Mexico (Albuquerque, NM) and Johns Hopkins University (Baltimore, MD).

Consent to Participate All participants provided written informed consent.

Consent for Publication The Cheyenne River Sioux Tribe provided consent to submit this manuscript with intent to publish.

Competing Interests The authors declare no competing interests.

Significance: This study provides critical data on self-reported COVID-19, chronic disease outcomes, and exposure to commercial nicotine products. Results from this unique Tribal community-driven study with a large sample size ($N = 562$ participants from 289 households) will help understand the role that environmental exposures played on increased COVID-19 mortality, help target public health interventions, and inform Tribal public health policies on emergency preparedness and exposure analyses.

Keywords

Vulnerable populations; Population-based studies; Personal exposures; Inhalation exposures; Epidemiology

Introduction

The use of tobacco in American Indian and Alaskan Native (AI/AN) communities was first documented in the 1500 s, when Europeans colonized and commercialized traditional tobacco applications. This exploitative process continued when the ceremonial use of traditional tobacco was banned in the U.S and reliance on commercially available products was necessary [1]. The Cheyenne River Sioux Tribe (CRST), located in South Dakota, is one of many Indigenous communities that has been targeted by the tobacco industry, resulting in increased exposure to nicotine [2, 3]. Indigenous communities across the U.S have a disproportionately high commercial tobacco use (cigarettes, electronic cigarettes (e-cig), etc.) compared to other racial and ethnic groups [4]. Despite nationally declining nicotine use, approximately 100,000 more AI/AN people began smoking over the last decade in the U.S [5]. Of concern is the rise in e-cig use among Indigenous youth which has outpaced use in other groups, with exclusive e-cig use estimated at 11.3% for Indigenous youth, compared to white youth at 7.1% [6].

Smoking is associated with several diseases (cancer, cardiovascular, and respiratory disease) that AI/AN people are already at higher risk for [7-9]. It is unknown how nicotine exposure impacted COVID-19 outcomes in this population, but we know AI/AN were disproportionately affected by the pandemic. Life expectancy for AI/AN dropped by 6.4 years from 2019 to 2021 (a 4-time greater decrease than in Non-Hispanic White populations) where they comprised 1.3% of total COVID-19 cases despite contributing to only 0.7% of the total US population [10-13]. Therefore, there is a great need to understand COVID-19, chronic health outcomes, and their association with nicotine exposure within the CRST. This was a critical need at the beginning of the pandemic due to the fact that the Tribe has been largely unsuccessful in changing active combustion tobacco use and behavior in the population while successfully protected population health from secondhand tobacco smoke exposure. Previous studies have found associations between nicotine and increased risk for severe COVID-19 outcomes, such as hospitalization [9, 14]. Additionally, newer e-cig products marketed as “tobacco free” products have been shown to reduce harm perception and increase likelihood of use [15]. Nicotine use behaviors, such as preferred nicotine concentration (%), and device characteristics, can modify chemical delivery and differentially affect health outcomes [16, 17].

The CRST is in a unique position to support policy development and detailed study of nicotine use because of decades-long partnerships with local researchers. Following advocacy from a multigenerational grassroots effort, the Canli (“Sacred Tobacco in Lakota language”) Coalition, the CRST Tribal Council took action to prevent harm from commercial tobacco and secondhand smoke by implementing the Smoke-Free Air Ordinance in 2015 and exposing e-cig companies’ illegal and predatory marketing on reservation land [2, 18]. In 2022, the CRST COVID-19 Wayakta-He?” (Are you on guard against COVID-19?) pilot study (5R21ES033119-02, PI Erdei) was launched to investigate how indoor exposures and nicotine use affect SARS-CoV-2 infection rates, and development of COVID-19 health outcomes. The specific purpose of this analysis was to describe the extent of self-reported COVID-19 and chronic disease outcomes with exposure to commercial nicotine by comparing exclusive e-cig users, cigarette users, dual e-cig/cigarette users, and nonusers among adult residents on the CRST. We hypothesized that nicotine exposure from both e-cig and combustion tobacco use would be associated with increased risk of negative COVID-19 and chronic health outcomes.

Methods

Study Population and Recruitment

The CRST COVID-19 – Wayakta He? Study was a cross-sectional pilot study designed to assess risk factors for COVID-19 that would adhere to Tribal COVID-19 safety guidelines. Between February 2022 and May 2023, we aimed to recruit two adults from each enrolled household at least 7 years apart in age to capture nicotine use and exposure across generations. Households were included if they were located on the CRST Reservation and if two adults met the inclusion criteria. Because increased risk of COVID-19 disease development was known to be linked to preexisting chronic disease conditions, we used a point-based scoring system based on nicotine use, self-reported chronic health conditions, and/or if they were diagnosed or had COVID-19 recently to pre-screen each person in the household [10]. We oversampled people who use e-cigs to capture this population due to high combustible cigarette smoking prevalence in the community. We granted only one point total for one or multiple chronic health conditions, because our team had previous experiences demonstrating that 46% of the population self-reported various chronic disease outcomes therefore the likelihood to sample them was quite high [18]. If more than two household members were interested in participating in the study, priority was given to the individuals with the two highest scores. The inclusion criteria are available in Table S1 of the Supplemental Material. Approval to conduct the study on sovereign tribal land was granted by the CRST. The study protocol was approved by the Great Plains Institutional Review Board (IRB), and the IRBs at the University of New Mexico (Albuquerque, NM) and Johns Hopkins University (Baltimore, MD). All participants provided written informed consent.

Data Collection

After confirming eligibility with MBIRI, informed consent was obtained. Then, participants privately filled out a 97-item survey on COVID-19-related questions, demographics, health behaviors, health outcomes, smoking and vaping behaviors, occupation, general health,

discrimination, and other stressors. All measurements, including tribal status, were identified by self-report due to Tribal law and sovereignty that strictly control such data collection or validation effort. One participant from each household (Head of Household) was given a longer survey with 15 additional questions on the environmental conditions of the home (type of fuel, occupancy, household income, and COVID-19 impact on the household). A sample of survey questions is shown in Table S2. Participants were categorized into four groups: nonusers, exclusive e-cig users, exclusive cigarette users (cigarette users), dual e-cig and cigarette users (dual users) based on responses to the survey. E-cig use was defined by using refillable modifiable devices (MODs), cartridge pod devices (PODs), or disposable devices (dPODs) most days of the week. Dual e-cig and tobacco cigarette use was defined as participants who indicated both current e-cig and cigarette use via self-report. We used questions from the National Institutes of Health PhenXtool standardized resource including information about COVID-19 infection, and impact of the COVID-19 outbreak to enhance generalizability of the Tribal response and allow direct comparisons to other pandemic-affected communities [19]. Study data were collected and managed using REDCap[®] (Research Electronic Data Capture) hosted at the University of New Mexico Health Sciences Center and supported by the UNM HSC Clinical Translational Science Center [20].

Statistical Analysis

Descriptive statistical analyses began by exploring the distributions of variables. Chi-square tests for categorical variables and Kruskal–Wallis tests for continuous variables were performed to assess differences in participant characteristics (age, gender, marital status, household income, ethnicity, education, work status, self-reported COVID-19, and COVID-19 vaccination) across nicotine use groups. Chi-squared tests were used to assess differences in nicotine use and nicotine user categories. Multiple linear regression, logistic regression, and ordinal logistic regression were used to analyze nicotine use behaviors and demographic characteristics, unadjusted and adjusted for age, sex, education, and working status. Household income and education were co-linear and correlated based on our previous data collections, so we opted to adjust for education in the models as household income was asked solely to the head of household while education question was asked of all participants allowing better stratification. We assessed self-reported cigarettes per day, cigarette frequency (days smoked per week), time to first smoke in the morning, e-cig puffs per day, nicotine concentration (%), type of e-cig device (MOD, POD, or dPOD), preferred e-cig flavor, time to finish 1 pod, vaping frequency (days used per week), and time to first vape in the morning. Time to first smoke/vape in the morning is a measure of physical addiction to nicotine and part of the Fagerstrom Test for Nicotine Dependence [21]. It was important to assess the intensity of tobacco dependence in this highly targeted, high-risk community. Additionally, we analyzed the total puffs per day for all users, converting the number of cigarettes per day to number of puffs by multiplying by 10, as is the standard number of puffs per cigarette [22]. We calculated median and inter-quartile range (IQR) for all variables by nicotine use category and conducted chi-squared tests between nicotine use groups.

The analysis of the number of cigarettes smoked per day was affected by an error in the survey. The question allowed multiple dropdowns for participants to choose the units of cigarettes (cigarettes/day, cigarettes/week, cigarettes/month, packs/day, packs/week, and packs/month), which caused confusion and inaccuracies. On preliminary analysis, we found that one hundred participants reported smoking less than 3 cigarettes per day resulting in a low mean cigarettes per day of 6.35. We attempted to validate these unlikely low number answers by contacting as many participants as was possible.. We successfully contacted 11 (of 100) participants, 10 of which clarified that their reported answers were incorrect and lower than the actual number of cigarettes/day. To avoid censoring a large proportion of responses, for participants reporting high frequency of use on other questionnaire responses (i.e., frequency of cigarette use, time to first smoke), we replaced those who reported less than 3 cigarettes per day with 20 cigarettes/day (1 pack) as a conservative estimate based on our team's previous extensive works in the community. The new median of 10 cigarettes/day after this substitution is in line with previous studies conducted by MBIRI in 2012 and 2019 [18, 23]. The 2012 study reported a mean of 11.5 cigarettes/day with a 50.9% prevalence of current smoking in a 57% female study population and the 2019 study reported smoking prevalence of 51% in a 52% female study population, indicating that cigarette smoking has not changed significantly in recent years, affects both genders almost equally and is applicable to our analyses and data imputation [18, 23]. Statistical analyses of this variable were conducted with both sets of data and shown in Tables S3 and S4.

Logistic regression and ordinal logistic regression were used to analyze the relationship between health outcomes and nicotine use status, adjusted for age, sex, and education. We analyzed the relationship for general health, frequency of flu-like illness, COVID-19 vaccination, self-reported COVID-19, COVID-19 recovery time, COVID-19 severity [mild infection (no medical intervention), moderate infection (medical intervention), and severe infection (hospitalization for more than 1 day and/or ventilator use)], long COVID (those with persistent symptoms 4 weeks or more after infection), previous lung disease, previous heart disease, hypertension, high cholesterol, anemia, asthma, diabetes, obesity, and joint disease [24]. Statistical analysis was conducted in RStudio Version 1.3.1093 (RStudio, PBC). The statistical significance level was set at $\alpha = 0.05$.

Results

Demographic Characteristics

The MBIRI staff recruited 560 participants in 289 households (17 exclusive e-cig users, 255 cigarette smokers, 29 dual users, 259 nonusers) (Table 1). Households recruited represented 21 out of 23 communities on the CRST. The prevalence of overall e-cig use (exclusive e-cig and dual users) in the study cohort was 8.2%. The participants' mean age was 42.4 years (SD = 15.7), 60% women with 95% of participants identifying as AI/AN. Exclusive e-cig users were significantly younger (mean age in years: 24.0, SD = 9.45) compared to cigarette smokers (42.6, SD = 13.9), dual users (32.4, SD = 8.55), and nonusers (44.5, SD = 17.0) ($p = 0.028$). More nonusers (8%) and exclusive e-cig users (6%) were not AI/AN compared to smokers (2%) and dual users (0%) ($p < 0.001$). Exclusive e-cig users (25%) and nonusers (28%) were more likely to have greater than a high school education compared to

cigarette smokers (18%) and dual users (14%) ($p = 0.044$). Exclusive e-cig users (41%) and nonusers (48%) were more likely to work full/part time, compared to smokers (26%) and dual users (10%) ($p < 0.001$). More nonusers (32%) were in the highest household income ($p < 0.001$) and the highest median monthly per capita income (median = 625, IQR = 225–1482) ($p < 0.001$) categories. Exclusive e-cig users (82%) and nonusers (76%) had the highest percentage of self-reported COVID-19 compared to dual users (66%) and smokers (58%) ($p = 0.002$). No significant differences were found in nicotine use category by gender, marital status, and vaccination status.

Nicotine Use Behaviors

More exclusive e-cig users chose dPODs (68%) than dual users who used both PODs (44%) and dPODs (41%) evenly ($p < 0.001$) (Table 2). The median years that participants were introduced to e-cigs and began regular use were 2019 and 2020, respectively. Most participants used e-cig devices every day (39%) and started vaping more than 15 min after waking up (74%). The preferred flavor types were fruit (43%), candy/dessert (24%), and mint (20%). Participants vaped at a median nicotine concentration of 5% (range = 2–6%) and reported a median of 14.5 puffs (IQR = 5–30) of their e-cig device per day. For cigarette use, participants' median cigarettes per day was 10 (IQR = 4–20) and was significantly different between exclusive cigarette smokers (10 (IQR = 4–20) and dual users (7.5 (IQR = 4.25–20) cigarettes per day)) ($p = 0.0432$). Most participants who used cigarettes smoked every day (58%) and started smoking more than 15 min after waking up (72%). The median total puffs per day for all nicotine use was 90 (IQR = 30–200) and was significantly different between cigarette, dual, and exclusive e-cig users ($p > 0.001$), with dual and cigarette smokers reporting more puffs per day than exclusive e-cig users.

Nicotine concentration (%) was positively associated with being older ($p = 0.015$) (Table 3). Greater total puffs per day for all nicotine use was positively associated with education in unadjusted models ($p = 0.023$). The odds of using POD devices were lower with increased age ($p < 0.001$) and working full/part time status compared to not working ($p = 0.031$) in adjusted models. The odds of POD use for having a high school GED were higher compared to not having a high school GED in adjusted models ($p < 0.001$). The odds of dPOD use were lower with increased age ($p < 0.001$) and working full/part time status compared to not working ($p = 0.0252$). The odds of dPOD use were higher with having a high school GED compared to not having a high school GED in adjusted models ($p < 0.001$). The proportional odds of smoking sooner after waking up were higher for students ($p < 0.001$) and those working full/part time ($p = 0.0436$) compared to those not currently working.

Self-Reported Health Outcomes

Some participants had been previously diagnosed with chronic health conditions: 17.8% with lung diseases, 4.09% heart diseases, 23.8% hypertension, 4.53% high cholesterol levels, 14.1% reported obesity, and 8.19% any form of anemia. Of the 68% of participants who had COVID-19 disease, 30.5% of them also had long COVID. The proportional odds of longer COVID-19 recovery time were 1.71 times higher for those who used nicotine versus nonusers ($p = 0.046$) (Fig. 1). The proportional odds of having more severe COVID-19 outcomes were 0.556 times lower for those who used nicotine versus nonusers ($p = 0.001$).

The proportional odds of having more severe COVID-19 were 2.55 times higher for those with a high school education/GED compared to those without ($p < 0.001$). The proportional odds of reporting worse general health were 1.46 times higher for those without a high school education/GED compared to those who completed high school ($p = 0.0473$) and 1.02 times higher with increased age ($p < 0.001$). The odds of having had COVID-19 were 0.452 times lower for those who use nicotine compared to nonusers ($p < 0.001$). The odds of hypertension ($p = 0.041$) and high cholesterol ($p = 0.0305$) were 0.653 times and 0.353 times lower for nicotine users compared to nonusers. The odds of heart disease ($p < 0.001$), hypertension ($p < 0.001$), high cholesterol ($p < 0.001$), diabetes ($p < 0.001$), obesity ($p = 0.0321$), and joint disease ($p < 0.001$) were all higher for increased age. The odds of anemia ($p < 0.001$), diabetes ($p = 0.0406$), and joint disease ($p = 0.0119$) were all higher for females compared to males. The odds of obesity were higher for those with a high school education/GED compared to those without ($p = 0.0251$).

Discussion

A recent study found that Northern Plains Tribes have a higher prevalence (around 50%) of smoking compared to Southwest Tribes, indicating that nicotine use differs by Tribe and geographical region [25]. While there are many similarities among AI/AN groups across the United States, it is important to investigate public health issues and support pandemic-related data collection and analyses on a local level due to geographic distinctions. The South Dakota Department of Tribal Relations estimated approximately 16,000 enrolled tribal members with the population living on the CRST Reservation land to be approximately 8600 in 2019 [26]. From those, approximately 4000 are children, leaving 4600 adults who were eligible to be enrolled on this study. It is likely that the population is greater considering the transient nature and employment dynamics of the CRST population and historical mistrust of the US government and non-participation in any census measurement [27]. However, using these conservative estimates, our study successfully captured nicotine use and health outcomes for approximately 12% of the total adult CRST population and was carried out to be community-based and representative of 21 out of 23 communities on the CRST Reservation land.

We found that more participants who were not AI/AN were non-nicotine users and in the upper income tertiles compared to other participants, which is consistent with previous findings [4]. The prevalence of nicotine use among Indigenous peoples is known to be higher compared to non-Hispanic White (NHW) Americans and is consistent with research done earlier on AI/AN nicotine use [28]. Previous studies have also found that income is highly stratified by race in the U.S. and AI/AN populations have lower representation in the top income groups than NHW [29]. Additionally, more nonusers and exclusive e-cig users were employed/working compared to cigarette smokers or dual users, which was similarly found in a previous study assessing tobacco use across US working adults [30].

Exclusive e-cig users were more likely to prefer dPODs compared to dual users who equally used dPODs and PODs. This is consistent with previous literature as dual users are reported to pick the type of delivery more by convenience/availability since they interchange between e-cigs and cigarettes [31]. Being older was positively associated with e-cig nicotine

percentage. In a previous study from our group conducted on a majority NHW population, we found no significant association between age and nicotine percentage but a trend in the same direction [17]. We also found that being older was negatively associated with the use of PODs and dPODs compared to MODs, and this relationship has been reported in previous studies [32, 33]. Having a high school education/GED was positively associated with the use of dPODs and PODs and preference for flavors over unflavored nicotine. The total number of puffs per day for all nicotine use was positively associated with education status. It is possible that use is associated with higher education as an indicator of income and ability to afford nicotine products [34]. We found significant differences between puffs per day by nicotine delivery type, with dual users using their e-cig devices more than exclusive e-cig users. This indicates that e-cig users do not use nicotine at the same rates based on their preferred nicotine delivery.

The prevalence of heart disease in this study population (4.09%) is not in line with national statistics on AI/AN prevalence (11.0%) [35]. The prevalence of obesity in this population (14%) is much lower than the projections adjusted for self-report bias of 50% obesity prevalence in South Dakota [36]. High cholesterol (4.53%) and hypertension (23.8%) were also found to be reported at lower rates than the national averages of 34.5% for high cholesterol and 46.7% for hypertension [9, 37]. Rates of anemia were in line with previous literature in the US [38]. It is possible that health effects are underreported and under-diagnosed in this study due to lack of consistent primary care providers and steady access to healthcare in this population [39]. Despite federally recognized AI/AN populations having guaranteed access to primary healthcare through the federal Indian Health Service system, decades-long mistrust, and underfunded facilities with not enough consistent, dedicated, primary care provider base are still major problems in the majority of AI/AN communities [11]. Additionally, a previous study found that 1 in 6 AI/AN participants reported avoiding going to a healthcare professional, even if they are available locally, because of concerns of mistreatment and provider bias [40].

Nicotine use was negatively associated with reporting COVID-19, hypertension, and high cholesterol compared to no use. One study found that nicotine users with COPD avoid seeking medical care because of apprehension about being ridiculed of their nicotine dependence [41]. This could result in a lower propensity to seek medical care and diagnosis for COVID-19, hypertension, and high cholesterol. While we found that nicotine use was negatively associated with more severe COVID-19, the relationship between nicotine and severity of COVID-19 infection is currently not well-established. A recent review found that tobacco use had mixed associations with infection of COVID-19, although the overall weight of the evidence shows that nicotine use exacerbates COVID-19 health outcomes [42]. Other studies indicate that nicotine use may be associated with increased chance of an asymptomatic COVID-19 infection, or even reduced severity, compared to nonusers [42-46]. As tobacco smoke is a known immunosuppressant and a well-documented respiratory toxicant, it is possible that exposures to various cigarette-associated chemicals have direct downregulatory effect on the lung's epithelial cytokine expression [47-49]. That could have also enhanced the occurrence of asymptomatic SARS-CoV-2 infections that further promoted viral particles' spread especially in crowded, tobacco-using Tribal households.

Furthermore, it has been shown that cigarette and e-cig use in adults is associated with worse health literacy [50]. It is possible that lower health literacy compared to non-use, historical mistrust of healthcare professionals, and stigma against nicotine use may be contributing factors to the lower odds of having reported COVID-19 infection, less severe COVID-19 outcomes that are might underreported, lower rates of diagnosed hypertension, and high serum cholesterol levels. It is possible that in this rural, lower than average educational-achievement reporting community, higher education likely contributes to an increased access to healthier food choices, tobacco, and alcohol products due to affordability and increased opportunities to seek to medical care, even off the Reservation. Higher health literacy level overall contributes to more disease diagnoses [34, 51, 52].

This study has several limitations. Our recruitment occurred during COVID-19 restrictions, which meant no in-person interviews were carried out. Recruitment spanned 15 months, encompassing winter and varying incidence rates of COVID-19 and uptake of vaccines against severe COVID-19 disease. Because of this, there could have been temporal changes in the questionnaire answers from participants that we could not capture in a cross-sectional design or in our models. Additionally, participants could have displayed recall or social desirability bias when answering questions, as many may know MBIRI employees personally. When asking to self-report certain health outcomes in our questionnaire, it is possible that chronic disease information was underestimated, and the actual prevalence of such medical conditions could not be obtained. Finally, due to the unpredictable nature of relying on self-reported questionnaire information, we had to rely on imputation to complete our analyses concerning data on the number of cigarettes per day, even though our estimates were based strongly on previous CRST-driven measures and published information [18, 23].

Notwithstanding these limitations mostly imposed by the COVID-19 pandemic, our study has many strengths and provides valuable information on nicotine use, COVID-19 disease, and pandemic conditions influencing health, which are especially relevant in the rural U.S. To our knowledge, this study is the first to collect such information based on community-engaged recruitment/enrollment approaches and assess relationships between health and nicotine use on a large scale within this high-risk rural Tribal population. Our large sample size of over 500 adult participants is another strength; we were able to capture a large portion of adults on the CRST (over 12% of the total eligible). This study can be applicable to other Northern Plains region Tribes, with similar cultural and behavioral patterns and the community-based participatory research methods can be used widely across the United States in other Native communities or high-risk, rural populations. We were able to capture nuanced information on self-reported health outcomes, including COVID-19 disease information otherwise never captured in AI/AN groups, and nicotine use behaviors in a population that has been historically underrepresented and abused in research and targeted by the industry. This study was only possible through strong, community-driven approaches, culturally relevant enrollment and outreach works, and Native researchers' dedication to its success.

We found trends in demographic characteristics with nicotine concentration, how soon after waking up they start smoking, total number of puffs per day, and use of e-cig devices. Nicotine users reported less high blood pressure, high cholesterol, and COVID-19 than non-

nicotine users, which was unexpected. However, when infected with COVID-19, nicotine users reported less severe symptoms but longer recovery time that might be related to complex chemical toxicant exposure via combustion tobacco use and its immunosuppressive effects in the lung. We found the CRST community has different nicotine use behaviors depending on the type of nicotine. This study provides critical data on COVID-19, chronic disease outcomes, and exposure to commercial nicotine products. Results from this unique Tribal community–driven study with a large sample size ($N = 562$ participants from 289 households) will help understand the role environmental exposures played on increased COVID-19 mortality, help target public health interventions, and inform Tribal public health policies on emergency preparedness and exposure analyses. This information can be used by CRST leadership to understand the relationships between nicotine and health outcomes as this information has not been reported within the community before and could be directly applied to increase health literacy locally and beyond.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Data Availability

The authors do not have permission to share tribal data.

References

1. Henderson PN, Lee JP, Soto C, et al. Decolonization of tobacco in Indigenous communities of Turtle Island (North America). *Nicotine Tob Res.* 2022;24(2):289. 10.1093/NTR/NTAB180. [PubMed: 34516637]
2. O’Leary RA, Zelikoff JT, Meltzer GY, Hemmerich N, Erdei E. The Cheyenne River Sioux Tribe resists JUUL’s targeted exploitation. *Tob Control.* 2023;32(e2):e267–8. 10.1136/TOBACCOCONTROL-2021-056813. [PubMed: 34933937]
3. Lempert LK, Glantz SA. Tobacco industry promotional strategies targeting American Indians/Alaska natives and exploiting tribal sovereignty. *Nicotine Tob Res.* 2019;21(7):940. 10.1093/NTR/NTY048. [PubMed: 29546392]
4. Arrazola RA, Griffin T, Lunsford NB, et al. Peer reviewed: US cigarette smoking disparities by race and ethnicity — keep going and going! *Prev Chronic Dis.* 2023;20:E45. 10.5888/PCD20.220375. [PubMed: 37262328]
5. Cornelius ME, Loretan CG, Wang TW, Jamal A, Homa DM. Tobacco product use among adults — United States, 2020. *Morb Mortal Wkly Rep.* 2022;71(11):397. 10.15585/MMWR.MM7111A1.

6. Seo YS, Chang YP. Racial and ethnic differences in e-cigarette and cigarette use among adolescents. *J Immigr Minor Health*. 2022;24:713–20. 10.1007/s10903-021-01229-0. [PubMed: 34106360]
7. Melkonian SC, Jim MA, Haverkamp D, et al. Disparities in cancer incidence and trends among American Indians and Alaska Natives in the United States, 2010–2015. *Cancer Epidemiol Biomark Prev*. 2019;28(10):1604–11. 10.1158/1055-9965.EPI-19-0288.
8. Mangione CM, Barry MJ, Nicholson WK, et al. Screening for chronic obstructive pulmonary disease: US Preventive Services Task Force Reaffirmation Recommendation Statement. *JAMA*. 2022;327(18):1806–11. 10.1001/jama.2022.5692. [PubMed: 35536260]
9. Breathett K, Sims M, Gross M, et al. Cardiovascular health in American Indians and Alaska Natives: a scientific statement from the American Heart Association. *Circulation*. 2020;141(25):E948–59. 10.1161/CIR.0000000000000773/FORMAT/EPUB. [PubMed: 32460555]
10. Hatcher SM, Agnew-Brune C, Anderson M, et al. COVID-19 among American Indian and Alaska Native persons — 23 States, January 31–July 3, 2020. *Morb Mortal Wkly Rep*. 2020;69(34):1166. 10.15585/MMWR.MM6934E1.
11. Erdei E, Meltzer G, Avenbun O, et al. Environmentally marginalized populations: the “perfect storm” for infectious disease pandemics, including COVID-19. *J Health Disparities Res Pract*. 2020;13:68–77.
12. Tieskens K, Patil P, Levy JJ, et al. Time-varying associations between COVID-19 case incidence and community-level sociodemographic, occupational, environmental, and mobility risk factors in Massachusetts. *Res Sq*. Published online February 17, 2021. 10.21203/RS.3.RS-237622/V1.
13. Goldman N, Andrasfay T. Life expectancy loss among Native Americans during the COVID-19 pandemic. *Demogr Res*. 2022;47:233. 10.4054/DEMRES.2022.47.9. [PubMed: 36506651]
14. Baker J, Krishnan N, Abrams LC, Berg CJ. The impact of tobacco use on COVID-19 outcomes: a systematic review. Published online 2022. 10.1155/2022/5474397.
15. Chen-Sanke J, Ganz O, Seidenberg A, Choi K. Effect of a “tobacco-free nicotine” claim on intentions and perceptions of Puff Bar e-cigarette use among non-tobacco-using young adults Brief report. *Tob Control*. 2023;32:501–4. 10.1136/tobaccocontrol-2021-056957. [PubMed: 34697090]
16. Aherrera A, Lin JJ, Chen R, et al. Metal concentrations in e-cigarette aerosol samples: a comparison by device type and flavor. *Environ Health Perspect*. 2023;131(12):127004. 10.1289/EHP11921. [PubMed: 38048100]
17. Tillery A, Aherrera A, Chen R, et al. Characterization of e-cigarette users according to device type, use behaviors, and self-reported health outcomes: findings from the EMIT study. *Tob Induc Dis*. 2023;21(December):1–11. 10.18332/TID/174710.
18. O’Donald ER, Miller CP, O’Leary R, et al. Active smoking, secondhand smoke exposure and serum cotinine levels among Cheyenne River Sioux communities in context of a Tribal Public Health Policy. *Tob Control*. 2020;29(5):570–6. 10.1136/TOBACCOCONTROL-2019-055056. [PubMed: 31462578]
19. Hamilton CM, Strader LC, Pratt JG, et al. The PhenX toolkit: get the most from your measures. *Am J Epidemiol*. 2011;174(3). 10.1093/aje/kwr193.
20. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform*. 2008;42:377–81. 10.1016/j.jbi.2008.08.010. [PubMed: 18929686]
21. Heatherton TF, Kozlowski LT, Frecker RC, Fagerstrom K-O. The Fagerström Test for Nicotine Dependence: a revision of the Fagerstrom Tolerance Questionnaire. *Br J Addict*. 1991;86(9). 10.1111/j.1360-0443.1991.tb01879.x
22. Hoffmann D, Hoffmann I. The changing cigarette, 1950–1995. *J Toxicol Environ Health*. 1997;50(4):307–64. 10.1080/009841097160393. [PubMed: 9120872]
23. Weber J. Cheyenne River Sioux Tribe adult tobacco survey findings. Ormond Beach, FL: JCW Research and Evaluation Group Inc; 2012.
24. Wanga V, Chevinsky JR, Dimitrov LV, et al. Long-term symptoms among adults tested for SARS-CoV-2 — United States, January 2020–April 2021. Published online 2021. https://www.cdc.gov/mmwr/mmwr_continuingEducation.html. Accessed 3 Jan 2024.

25. Tanner JA, Henderson JA, Buchwald D, Howard BV, Nez-Henderson P, Tyndale RF. Relationships between smoking behaviors and cotinine levels among two American Indian populations with distinct smoking patterns. *Nicotine Tob Res.* Published online 2018:466–473. 10.1093/ntr/ntx114. [PubMed: 28549179]
26. Cheyenne River Sioux Tribe | South Dakota Department of Tribal Relations. <https://sdtribalrelations.sd.gov/tribes/Cheyenne-River-Sioux-Tribe.aspx>. Accessed 10 July 2024.
27. Chiago Lujan C. American Indians and Alaska Natives count: the US Census Bureau's efforts to enumerate the Native population. *Am Indian Q.* 2014;38(3). 10.5250/amerindiquar.38.3.0319.
28. Cushing C, Gildemaster M, Jones J. *The Health Behaviors of South Dakotans* 2021. 2023.
29. Akee R, Jones MR, Porter SR. Race matters: income shares, income inequality, and income mobility for all U.S. races. *Demography.* 2019;56(3):999–1021. 10.1007/S13524-019-00773-7. [PubMed: 30945204]
30. Syamlal G, King BA, Mazurek JM. Tobacco use among working adults — United States, 2014–2016. *Morb Mortal Wkly Rep.* 2017;66(42):1130. 10.15585/MMWR.MM6642A2.
31. Coleman SRM, Piper ME, Byron MJ, Bold KW. Dual use of combustible cigarettes and e-cigarettes: a narrative review of current evidence. *Curr Addict Rep.* 2022;9(4):353–62. 10.1007/s40429-022-00448-1. [PubMed: 36467719]
32. Williams R. The rise of disposable JUUL-type e-cigarette devices. *Tob Control.* 2020;29:134–5. 10.1136/tobaccocontrol-2019-055379.
33. Kong G, Bold KW, Morean ME, et al. Appeal of JUUL among adolescents. *Drug Alcohol Depend.* 2019;205: 107691. 10.1016/J.DRUGALCDEP.2019.107691. [PubMed: 31706249]
34. Bayati T, Dehghan A, Bonyadi F, Bazrafkan L. Investigating the effect of education on health literacy and its relation to health-promoting behaviors in health center. Published online 2018. 10.4103/jehp.jehp_65_18.
35. Lee YTH, Fang J, Schieb L, Park S, Casper M, Gillespie C. Prevalence and trends of coronary heart disease in the United States, 2011 to 2018. *JAMA Cardiol.* 2022;7(4):459–62. 10.1001/JAMACARDIO.2021.5613. [PubMed: 35044425]
36. Ward ZJ, Bleich SN, Cradock AL, et al. Projected U.S. state-level prevalence of adult obesity and severe obesity. *N Engl J Med.* 2019;381(25):2440–50. 10.1056/nejmsa1909301. [PubMed: 31851800]
37. Tsao CW, Aday AW, Almarzooq ZI, et al. Heart disease and stroke statistics—2023 update: a report from the American Heart Association. *Circulation.* 2023;147(8):e93–621. 10.1161/CIR.0000000000001123. [PubMed: 36695182]
38. Huu C, Le H. The prevalence of anemia and moderate-severe anemia in the US population (NHANES 2003-2012). Published online 2016. 10.1371/journal.pone.0166635.
39. Pomerville A, Kawennison Fetter A, Gone JP. American Indian behavioral health treatment preferences as perceived by Urban Indian Health Program providers. *Qual Health Res.* 2022;32(3):465–78. 10.1177/10497323211057857/FORMAT/EPUB. [PubMed: 34919004]
40. Findling MG, Casey LS, Fryberg SA, et al. Discrimination in the United States: experiences of Native Americans. *Health Serv Res.* 2019;54(S2):1431–41. 10.1111/1475-6773.13224. [PubMed: 31657013]
41. Khan I. Stigma towards patients with chronic obstructive pulmonary disease: to help or to judge? *Biomed Res Clin Rev.* 2021;4(3). 10.31579/2692-9406/063.
42. Benowitz NL, Goniewicz ML, Halpern-Felsher B, et al. Tobacco product use and the risks of SARS-CoV-2 infection and COVID-19: current understanding and recommendations for future research. *Lancet Respir Med.* 2022;10(9). 10.1016/S2213-2600(22)00182-5.
43. Kloc M, Ghobrial RM, Kubiak JZ. How nicotine can inhibit cytokine storm in the lungs and prevent or lessen the severity of COVID-19 infection? *Immunol Lett.* 2020;224:28–9. 10.1016/J.IMLET.2020.06.002. [PubMed: 32522666]
44. Shaaban AN, Andersson F, Peña S, et al. The association between tobacco use and risk of COVID-19 infection and clinical outcomes in Sweden: a population-based study. *Int J Public Health.* 2023;68. 10.3389/ijph.2023.1606175.

45. Young-Wolff KC, Slama MPH, Alexeeff SE, et al. Tobacco smoking and risk of SARS-CoV-2 infection and disease severity among adults in an integrated healthcare system in California. 2023;25:211–220. 10.1093/ntr/ntac090.
46. Jamalkandi SA, Ghanei M, Salehi Z, Fatemeh B, Motlagh Ghoochani N, Nourian YH. The controversial effect of smoking and nicotine in SARS-CoV-2 infection. 10.1186/s13223-023-00797-0.
47. Elisia I, Lam V, Cho B, et al. The effect of smoking on chronic inflammation, immune function and blood cell composition. Sci Rep. 2020;10(1). 10.1038/s41598-020-76556-7.
48. Mehta H, Nazzal K, Sadikot RT. Cigarette smoking and innate immunity. Inflamm Res. 2008;57(11). 10.1007/s00011-008-8078-6.
49. Qiu F, Liang CL, Liu H, et al. Impacts of cigarette smoking on immune responsiveness: Up and down or upside down? Onco-target. 2017;8(1). 10.18632/oncotarget.13613.
50. Clifford JS, Lu J, Blondino CT, Do EK, Prom-Wormley EC. The association between health literacy and tobacco use: results from a nationally representative survey. J Community Health. 2022;47(1):63–70. 10.1007/s10900-021-01019-7. [PubMed: 34357496]
51. Grytten J, Skau I, Sørensen R. Who dies early? Education, mortality and causes of death in Norway. Soc Sci Med. 2020;245. 10.1016/J.SOCSCIMED.2019.112601.
52. Fedeli U, Avossa F, Goldoni CA, Caranci N, Zambon F, Saugo M. Education level and chronic liver disease by aetiology: a proportional mortality study. Dig Liver Dis. 2015;47(12):1082–5. 10.1016/J.DLD.2015.07.154. [PubMed: 26315625]

Impact Statement

This study provides critical data on self-reported COVID-19, chronic disease outcomes, and exposure to commercial nicotine products, including electronic cigarettes. Results from this unique Tribal community–initiated and community-driven study with a large sample size ($N = 562$ participants from 289 households) will help explain the role that environmental exposures played on Tribal communities' 3.7 times increased mortality from COVID-19 disease, target public health interventions, and inform Tribal public health policies on emergency preparedness and exposure analyses.

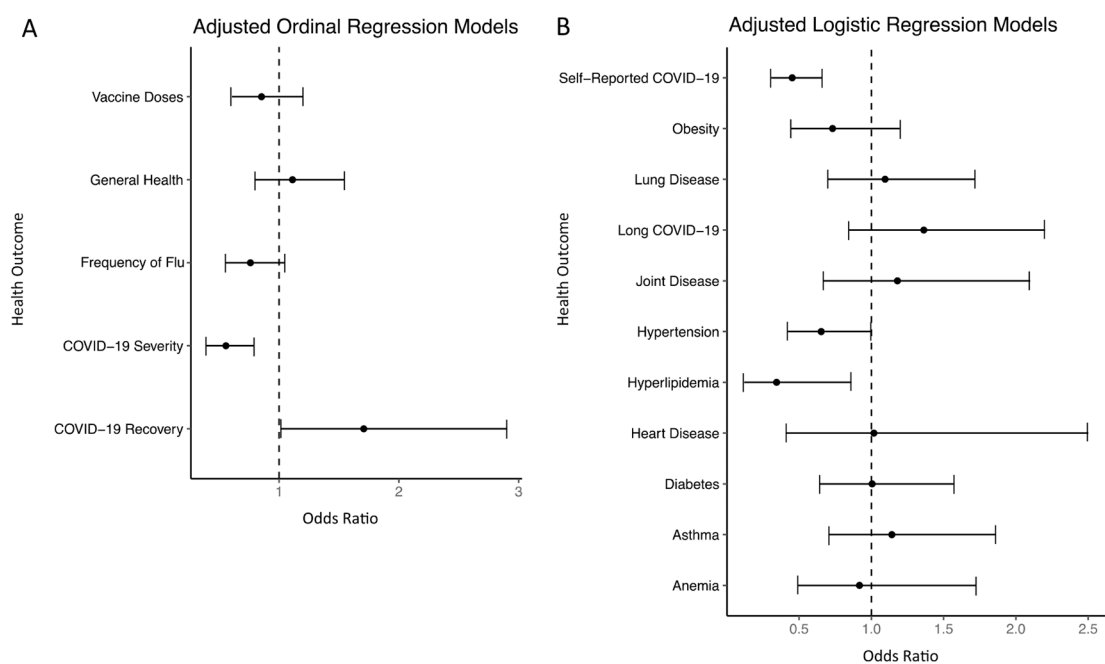


Fig. 1. Difference in health outcomes by nicotine use [non-use of nicotine (ref) by any use], analyzed using ordinal (A) and logistic (B) regression from the CRST COVID-19 Wayakta He? Study, 2022–2023. Models adjusted for age, gender, and education

Table 1

Sociodemographic characteristics of participants by nicotine use category ($n = 560$) from the CRST COVID-19 Wayakta He? cross-sectional study, 2022–2023

Variable	N, %	Overall 560	Exclusive e-dig users 17 (3.0)	Cigarette smokers 255 (45.5)	Dual users 29 (5.2%)	Nonusers 259 (46.3)	p-value*
Age, mean (SD)	560	42.4 (15.7)	24.0 (9.45)	42.6 (13.9)	32.4 (8.55)	44.5 (17.0)	0.028
Gender, %							0.735
Male	224	40	47	40	52	38	
Female	334	60	53	60	48	62	
AI/AN, %							0.001
Yes	533	95	94	98	100	92	
No	27	5	6	2	0	8	
Marital status, %							0.993
Not in a relationship	313	56	59	56	55	56	
Married/partnered	248	44	41	44	45	44	
Education, %							0.044
Less than HS/GED	113	20	17	18	24	17	
HS/GED	335	60	58	65	62	55	
Greater than HS	114	20	25	18	14	28	
Work status, %							< 0.001
Not currently working	329	59	47	73	80	43	
Student	29	5	12	10	10	9	
Working full or part time	201	36	41	26	10	48	
Household income, %							< 0.001
0–2000 monthly	259	59	36	78	84	40	
2001–4001 monthly	103	23	43	17	16	28	
5000 + monthly	80	18	21	5	0	32	
Per capita household income, median (IQR)	398	300 (125, 938)	500 (292, 1204)	162 (82, 350)	125 (68, 394)	625 (225, 1482)	< 0.001
COVID-19 Vaccination Status, %							0.514
No vaccine	87	16	6	17	7	15	
Vaccinated	471	84	94	83	93	85	
Self-reported COVID-19, %							0.002

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Variable	N, %	Overall 560	Exclusive e-cig users 17 (3.0)	Cigarette smokers 255 (45.5)	Dual users 29 (5.2%)	Nonusers 259 (46.3)	p-value [*]
No	182	32	18	42	34	24	
Yes	378	68	82	58	66	76	

^{*} p-values from chi-squared analysis

Table 2

Self-reported nicotine use behaviors stratified by type of nicotine use (e-cigarettes, cigarettes, dual use) ($n = 301$) from the CRST COVID-19 Wayakta He? cross-sectional study, 2022–2023

Variable	N	Overall	Exclusive e-cig users	Dual users	Cigarette smokers	p-value
Devices used	53					
MODs	7	13%	11%	15%		< 0.001
PODs	18	34%	21%	41%		< 0.001
dPODs	28	53%	68%	44%		< 0.001
Year introduced to e-cigs, median (IQR)	35	2019 (2018–2021)	2019 (2018–2021)	2020 (2016–2021)		0.47
Year regular e-cig use began, median (IQR)	32	2020 (2019–2022)	2021 (2020–2022)	2020 (2019–2021)		0.214
Vape frequency	46					0.6
Everyday	18	39%	47%	34%		
Some days	11	24%	24%	24%		
Seldom	8	17%	24%	14%		
Rarely	9	20%	6%	28%		
How soon after waking up do you vape?	46					0.241
15 min or less	12	26%	24%	28%		
More than 15 min	34	74%	76%	72%		
Preferred flavor categories	46					0.438
Fruit	21	46%	53%	41%		
Candy/dessert	11	24%	18%	28%		
Tobacco	5	11%	6%	14%		
Mint	9	20%	24%	17%		
Nicotine concentration (%), median (IQR)	20	5 (2–6)	5 (3.1–6)	5 (2–6)		0.268
How long to finish 1 pod?	19					
Less than 1 week	10	53%	38%	64%		0.219
More than 1 week	9	47%	62%	36%		
E-cigarette puffs per day, median (IQR)	33	14.5 (5–30)	15 (5–27)	10 (5–30)		0.585
Total puffs per day (e-cigs and cigarettes), median (IQR)	261	90 (30–200)	15 (5–200)	20 (7.5–93)	100 (40–200)	< 0.001
Number of cigarettes per day, median (IQR)	234	10 (4–20)		7.5 (4.25–20)	10 (4–20)	0.0432
Cigarette frequency	283					0.817
Everyday	165	58%		66%	57%	

Variable	N	Overall	Exclusive e-cig users	Dual users	Cigarette smokers	p-value
Some days	65	23%		17%	24%	
Seldom	36	13%		10%	13%	
Rarely	17	6%		7%	6%	
How soon after waking up do you smoke?	284					0.85
15 min or less	79	28%		31%	27%	
More than 15 min	205	72%		69%	73%	

* p-values from chi-squared analysis

Table 3
Difference in nicotine use behaviors by demographic characteristics analyzed using linear, logistic, and ordinal regression ($n = 285$) from the CRST COVID-19 Wayakta He? Study, 2022–2023

Multiple linear regression*									
Characteristic	E-cig puffs per day		Nicotine concentration (%)		Total puffs/day		Cigarettes per day		
	Unadj	Adj	Unadj	Adj	Unadj	Adj	Unadj	Adj	
Age	Coef	– 3.6	0.57	0.704	1.28	0.493	0.0553	0.0429	
	<i>p</i> -value	0.566	0.00728	0.0154	0.0982	0.556	0.168	0.325	
Gender	Male	ref	ref	ref	ref	ref	ref	ref	
	Female	104	– 1.55	1.63	24.4	15.9	0.0985	– 0.486	
	<i>p</i> -value	0.322	0.671	0.749	0.261	0.475	0.929	0.668	
Education	< HS/GED	ref	ref	ref	ref	ref	ref	ref	
	HS/GED	190	192	– 1.41	57.7	54.5	1.76	1.48	
	<i>p</i> -value	0.123	0.197	0.246	0.0202	0.0444	0.162	0.283	
	> HS/GED	98.9	124	– 2.84	18	18	0.186	0.208	
	<i>p</i> -value	0.256	0.2	0.553	0.318	0.323	0.839	0.824	
Work	Not working	ref	ref	ref	ref	ref	ref	ref	
	Student	– 95.8	171	– 3.12	– 107	– 97.2	– 3.5	– 2.89	
	<i>p</i> -value	0.555	0.463	0.671	0.11	0.153	0.47	0.558	
	Working	– 77.4	133	– 6.78	– 11.6	– 28.1	– 0.109	– 0.587	
	<i>p</i> -value	0.558	0.522	0.219	0.631	0.26	0.929	0.645	
Logistic regression*									
Characteristic	Uses MODs (no (ref))		Uses PODs		Uses dPODs		Preferred flavor (non-flavored tobacco (ref))		
	Unadj	Adj	Unadj	Adj	Unadj	Adj	Unadj	Adj	
Age	Coef	0.966	0.922	0.918	0.915	0.880	0.992	0.996	
	<i>p</i> -value	0.213	0.045	< 0.001	< 0.001	< 0.001	0.835	0.938	
Gender	Male	ref	ref	ref	ref	ref	ref	ref	
	Female	0.486	0.420	0.412	1.03	1.15	1.66	1.76	
	<i>p</i> -value	0.361	0.281	0.071	0.937	0.735	0.531	0.503	
Education	< HS/GED	ref	ref	ref	ref	ref	ref	ref	
	HS/GED	1.23	3.06	1.94	1.34	7.03	0.945	0.843	

<i>p</i> -value	0.711	0.131	0.270	< 0.001	0.530	< 0.001	0.957	0.880
> HS/GED	2,676,445	8,040,485	0.873	1.37	0.829	1.21	1.41	1.47
<i>p</i> -value	0.991	0.994	0.750	0.511	0.575	0.604	0.630	0.613
Not working	ref	ref	ref	ref	ref	ref	ref	ref
Student	2.05*10 ⁻⁷	2.78*10 ⁻⁹	3.03	1.04	1.88	0.52	1.33*10 ⁻⁷	1.33*10 ⁻⁷
<i>p</i> -value	0.994	0.998	0.100	0.955	0.333	0.360	0.994	0.995
Working	0.651	0.448	0.400	0.208	0.502	0.301	0.952	0.701
<i>p</i> -value	0.610	0.424	0.160	0.031	0.149	0.025	0.956	0.969

Ordinal regression*

Characteristic	How long to finish 1 POD		Vaping Frequency		Cigarette Frequency		How soon after waking up: Vaping		How soon after waking up: Smoking	
	Unadj	Adj	Unadj	Adj	Unadj	Adj	Unadj	Adj	Unadj	Adj
Age	Coef	1.02	1.06	0.987	0.946	1.00	0.989	0.980	1.00	1.01
	<i>p</i> -value	0.430	0.105	0.557	0.829	0.964	0.608	0.460	0.597	0.467
Gender	Male	ref	ref	ref	ref	ref	ref	ref	ref	ref
	Female	0.694	0.729	0.476	0.511	0.785	0.547	0.548	1.38	1.28
Education	<i>p</i> -value	0.546	0.616	0.085	0.132	0.303	0.164	0.189	0.144	0.270
	< HS/GED	ref	ref	ref	ref	ref	ref	ref	ref	ref
	HS/GED	0.447	0.232	0.953	0.771	0.850	0.855	1.29	1.11	0.940
	<i>p</i> -value	0.319	0.126	0.317	0.633	0.571	0.746	0.661	0.668	0.821
	> HS/GED	0.933	0.652	1.071	1.095	0.718	0.881	0.948	0.880	0.835
	<i>p</i> -value	0.900	0.489	0.846	0.813	0.103	0.721	0.895	0.486	0.336
Not working	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
Student	1.41	2.61	1.36	1.04	2.72	3.56	0.469	0.470	2.62*10⁻⁶	2.93*10⁻⁶
<i>p</i> -value	0.651	0.257	0.644	0.952	0.338	0.222	0.243	0.310	< 0.001	< 0.001
Working	1.34	1.59	0.440	0.448	0.901	0.942	0.596	0.581	1.67	1.60
<i>p</i> -value	0.680	0.529	0.115	0.129	0.700	0.831	0.322	0.307	0.046	0.073

* Adjusted models: age, gender, education, and work status

Values in bold are statistically significant